2.9 Fluvial Erosion Hazard Area Zoning

BACKGROUND AND PURPOSE

The purpose of adopting fluvial erosion hazard (FEH) zoning is to limit development in fluvial erosion hazard areas for the purpose of protecting public and private property, and public safety and welfare. Informed by geomorphic channel assessment and management practices endorsed by the New Hampshire Department of Environmental Services (DES) and New Hampshire Geological Survey, this model fluvial erosion hazard ordinance recommends implementation of development requirements and standards that recognize a stream's natural evolution and range of stable conditions.

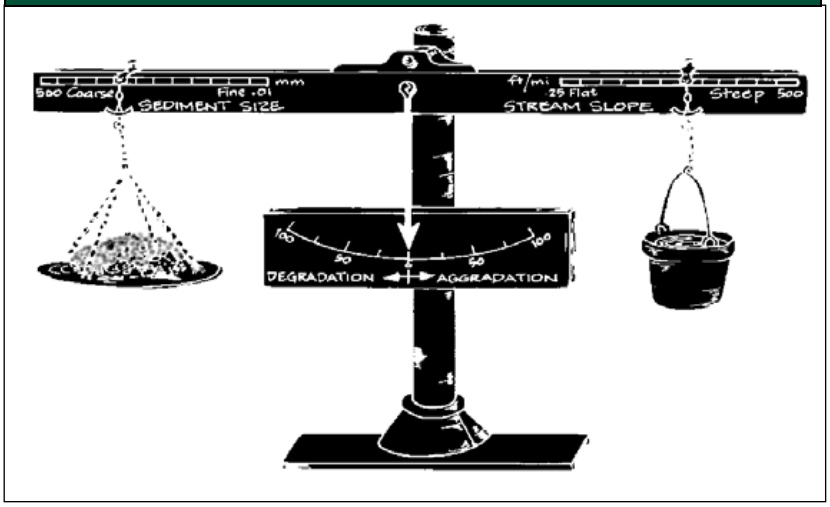
Ultimately, the most effective way to prevent hazards associated with fluvial erosion is ***avoidance by limiting future human presence and investments in river corridors***. The objective of this type of zoning is to guide and encourage measures and improvements that provide increased property and infrastructure protection, and maintain or restore the hydrologic and geomorphic functions and economic values of river systems. The functions and values of healthy river systems include: flood mitigation, water supply, water quality, sediment storage and transport, aquatic habitat, recreation, transportation and aesthetic qualities.

In the broader context, the purposes for adopting fluvial erosion hazard zoning are to achieve the following:

1. Protect public and private property, and public safety and welfare.
2. Address fluvial erosion hazards in the existing built environment.
3. Limit new development within fluvial erosion hazard zones to minimize property loss and damage due to fluvial erosion.
4. Minimize or prevent fluvial erosion hazards in the future.
5. Implement related goals and objectives of local and regional master plans, and supporting river corridor management plans.
6. Protect mapped river and stream corridors that are highly subject to erosion due to naturally occurring stream channel migration and adjustment.
7. Allow rivers and streams to maintain or re-establish their natural equilibrium; thereby avoid the need for costly and environmentally degrading stream channelization and bank stabilization measures.
8. Encourage activities that increase awareness of stream processes and the development of river restoration and mitigation projects.

Fluvial geomorphology is the study of interaction of water and the landscape through which it flows. Rivers and streams are dynamic systems that balance water flow and sediment transport. This dynamic condition is referred to as the equilibrium condition, where the discharge and the processes of erosion and sedimentation can maintain a stable river system.

FIGURE 1. Diagrammatic illustration of relationship between hydrologic process and the physical form and stability of rivers[1]



To maintain stability in hydrologic process and physical form, a river's energy must be in balance with the volume of water conveyed and the size and volume of sediment it carries. ***Fluvial erosion*** is the natural process of the wearing away of soil, vegetation, sediment, and rock from the river channel bed and banks by the action of water.

When river channels are altered by humans or nature, the river must readjust to reach its former balance. Such riverine adjustments occur to the channel and to the floodplain or the active river area, including changes in dimension, profile and pattern or course on the landscape. It is important to recognize that erosion is an ongoing natural river process that can be slowed but not stopped. The rate of erosion is affected by local soil type, slope, precipitation, and volume and velocity of river discharge. Other natural or human activities accelerate the natural rate of erosion, such as large storm events, removal or alteration of riparian vegetation, modification of runoff flow patterns, and physical alteration of land within the floodplain and the active river area.

People often overlook that rivers are systems in dynamic equilibrium, or a constant state of geomorphic adjustment. Thus buildings and other structures are often built too close to river banks and areas of active river processes, including erosion. The most severe fluvial erosion events in recent years resulted from prolonged heavy rains and repetitive rain events.

Fall 2005. In October 2005, nine to 11 inches of rain fell over a period of several days in parts of New Hampshire causing widespread evacuations, loss of life and damage to private property and public infrastructure. The most catastrophic damages occurred in the western areas of New Hampshire in the Cold River, Ashuelot River, and Beaver Brook watersheds, and along the Connecticut River.

Spring 2006. In mid-May 2006, eight to 12 inches of continuous heavy rain during a three-day period caused severe flooding and fluvial erosion damage across much of the state, including evacuations, road closures, and damage to private property and public infrastructure.

Other, more localized intense flooding has occurred recently, as well, that has caused sever property damage and loss of life here since severe flooding has occurred since 2006.

Table 1. Summary of flood damage statistics for New Hampshire since 1978 (Note: statistics may include both flood inundation and erosion related damages.)

County	NFIP Policies	Insurance In Force	Total Paid Losses*	Total Paid Amount*	Total Repetitive Loss Properties**
Belknap	331	$62,819,300	91	$754,070	13
Carroll	542	$103,710,800	205	$917,674	11
Cheshire	552	$104,428,400	175	$4,418,672	0
Coos	196	$26,653,200	64	$358,739	4
Grafton	895	$136,516,500	192	$1,296	19
Hillsborough	1,317	$277,353,200	530	$235	64
Merrimack	610	$120,398,600	258	$9,120,271	49
Rockingham	3,790	$638,515,800	1,552	$5,128,165	132
Strafford	450	$92,592,800	111	$15,002	10
Sullivan	172	$31,745,700	33	$917	2
Total	***8,855***	***$1,594,734,300***	***3,211***	***$39,111,157***	***304***

Source: FEMA Community Information System (September 23, 2008)
NFIP = National Flood Insurance Program
* Cumulative total paid losses since 1978
** "Repetitive Loss" means flood-related damage sustained by a structure on two separate occasions during a 10-year period for which the cost of repairs at the time of each flood event, on the average, equals or exceeds 25 percent of the market value of the structure before the damage occurred.

APPLICATION OF FLUVIAL EROSION HAZARD SCIENCE

Many rivers and streams in New Hampshire are rapidly changing due to various natural and human induced causes:

- Accelerated land development in susceptible areas.
- Increased stormwater discharge due to growth and development.
- Alteration of natural drainage systems and hydrologic processes.
- Regional patterns of precipitation due to potential global climate shifts.
- Traditional river management practices that do not support natural hydrologic processes.

While a significant proportion of damage from high flow events in New Hampshire results from inundation, a major component also comes from fluvial erosion. Constraining flows within river channels or other drainage structures does not allow the energy of water to flow within the active river area and onto the floodplain, often resulting in even higher flows with increased erosive power. Confining channel movement by placing roads, embankments and other structures in the active river area further increases erosion and potential risk bank and/or structural failure.

Fluvial erosion is erosion caused by rivers and streams, and can range from gradual bank erosion to catastrophic changes in river channel location and dimension during flood events.

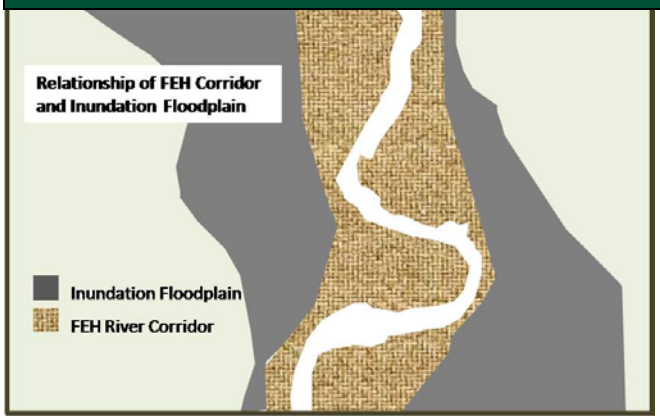
Breaking the cycle of encroachment within active river areas through FEH-based river corridor protection provides the following benefits:

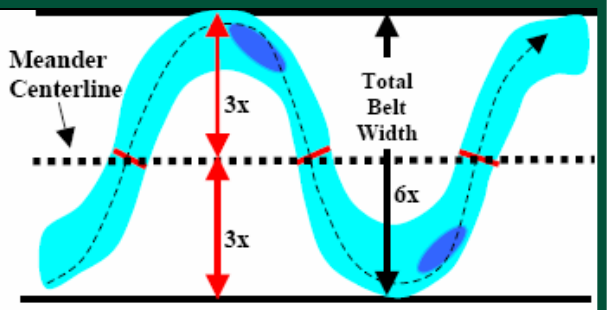
- Enhances public safety.
- Minimizes economic losses.
- Avoids land use constraints which prevent maintenance or achievement of river dynamic equilibrium condition.
- Provides low cost solutions.
- Manages towards sustainable healthy river conditions.

Meander Belt–Based River Corridors and Floodplains

In most instances, the geologic land forms within a river valley control the location of the active river channel, floodplain and valley wall. The natural stability and balance in a river system will depend on the river's opportunity to build and access a floodplain and create meanders that help evenly distribute the energy and sediment load along the cross-section and profile of the river through the valley. Where rivers are at or near equilibrium, the lateral extent of their meanders represent the *meander belt*, which is drawn as two roughly parallel lines following the river down-valley and capturing existing meanders (see Figure 2 below right). Together, identification of the meander belt width and the extent of the valley wall largely determine the geographic width and location of the FEH zones within the valley.

Figure 2. Method of mapping FEH zones and their relationship to the floodplain





[from *River Corridor Protection Guide: Fluvial Geomorphic-Based Methodology to Reduce Flood Hazards and Protect Water Quality by the Vermont Agency of Natural Resources*]

Floodplains and river corridors based on meander belt-widths overlap in the landscape. The non-channel portion of the river corridor is either active or abandoned floodplain. In wider valleys, flood-plains are typically wider than the meander belt width (see Figure 2 above left). Both the active and abandoned portions of the floodplain are worthy of protection for different though complementary objectives – protecting public safety and property. Although the active river corridor may provide flood storage when it consists of active floodplain, its fundamental intent is to provide the area a river needs to re-establish

or maintain equilibrium conditions over time, specifically the meander (stream length) and slope requirements of a stable stream channel. The river corridor also represents land most vulnerable to erosion from flooding.

APPROPRIATE CIRCUMSTANCES AND CONTEXT FOR USE

Why in New Hampshire?

Rivers are among the most beautiful features of nature, but they can also be destructive agents. During three major flood events between 2005 and 2007, damages from flooding, which represents New Hampshire's greatest natural hazard risk, cost the state $75.6 million. Major bank erosion and failure, road washouts, and catastrophic damage to homes and businesses along rivers are results of flood events, usually caused by fluvial erosion. As a result of the consequences of fluvial erosion and the recent flood disasters New Hampshire has experienced, a statewide FEH program has been a high priority with the Legislature, DES, New Hampshire Geological Survey (NHGS), and the Department of Safety.

Identifying Causes and Effects

The risk of fluvial erosion is increasing, as greater land development in watersheds produces greater stormwater inputs, resulting in higher flows with more power to produce severe fluvial erosion. Natural differences in local soils and surface materials, geology, and land use adjacent to rivers determine those areas most susceptible to fluvial erosion. When this information is combined with a field assessment of a river's present condition – i.e., channel dimensions, channel and bank condition, discharge regime, sediment transport regime, and adjacent floodplain vegetation – zones depicting the sensitivity to potential erosion can be delineated on maps. This information is gathered and analyzed through development of a ***geomorphic assessment*** of a river, its tributaries and its watershed.

Science and Policy

In 2008, the state received a Federal Emergency Management Association (FEMA) grant to develop pilot protocols for New Hampshire, based on protocols developed by Vermont, to complete a geomorphic assessment of 48 miles of the Exeter River and several of its tributaries. By 2009, the DES and NHGS initiated studies of the fluvial erosion hazards in New Hampshire. The project was significant because it actively engaged multiple stakeholders, including state agencies, regional planning commissions, local watershed organizations, and individuals in a comprehensive approach to develop a watershed based restoration and management plan based upon the results of the geomorphic assessments. ***This project also provided valuable science and tools from which this model FEH ordinance was developed.***

In 2009-2010, DES and NHGS undertook additional geomorphic watershed assessments utilizing the approach from the Exeter watershed pilot project. These assessments include the Ammonoosuc River and Isinglass River watersheds in 2009 and the Cocheco and Lamprey River watersheds in 2010. Additional river watersheds throughout the state will be assessed in the coming years.

Long-Term Goals of FEH Science and Regulation

DES and NHGS identified as priority actions the study and regulation of FEH areas and implementation of the following long-term goals:

- Work with Vermont to create a joint New Hampshire-Vermont regional fluvial erosion hazard program.
- Integrate river corridor protection for flood mitigation and restoration purposes.
- Develop programmatic capacity to serve as a national model in river and floodplain management.

Enhancement of NFIP Provisions and Local Floodplain Ordinances

The FEMA Community Rating System (CRS) program encourages towns to pursue activities that go above and beyond the minimum National Flood Insurance Program (NFIP) standards, such as restricting all development within the 100-year floodplain, requiring additional construction setbacks, and initiating conservation agreements and outreach programs. Since these activities can help reduce or eliminate the severity of future flood and related losses, towns participating in the CRS program are rewarded with discounts to flood insurance premium rates on flood insurance policies sold for properties within the community. *When fluvial erosion hazard areas are concurrent with the 100-year floodplain, implementation of fluvial erosion hazard zoning enhances the prevention of future damage by prohibiting new development in these high-risk areas and thus improve community performance under the federal CRS program.*

Refer to the Vermont River Management Program's four model regulations that combine NFIP floodplain and FEH zone regulation. Note Model Regulations 3 and 4 provide substantial rating points for the FEMA CRS Program. These documents are available from the Vermont website at http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_floodhazard.htm.

LEGAL BASIS AND CONSIDERATIONS FOR NEW HAMPSHIRE

ENABLING STATUTES

While previously a municipality could have developed a fluvial erosion hazard ordinance under the innovative land use provisions of RSA 674:21, legislation effective July 13, 2009 clearly grants such authority to New Hampshire municipalities and delineates the procedures for implementing fluvial erosion hazard zoning. RSA 674:56 Flood Hazards, section II states that such ordinances can be adopted under the zoning enabling statues (RSA 674:16 and 17) utilizing the existing zoning adoption procedures (RSA 675). Fluvial erosion hazard ordinances may be adopted as part of an existing zoning ordinance or as a stand alone ordinance, so long as it is administered in the same fashion as the zoning ordinance.

These new provisions of RSA 674:56 Flood Hazards, section II were established in conjunction with the creation of a new fluvial erosion hazard program at DES in response

to the recent and frequently severe riverine flood and erosional events in New Hampshire. Any fluvial erosion hazard zoning shall be based on delineation of zones consistent with any geomorphic and fluvial erosion hazard protocols established by DES in effect on the date of its adoption. If a municipality proposes to adopt, by ordinance or amendment, a fluvial erosion hazard ordinance or an amendment to a fluvial erosion hazard ordinance, the municipality shall submit to DES a map of all fluvial erosion hazard zones. DES shall review the map and advise the board within 30 days whether the map and zones are consistent with department protocols. The department's comments, if any, shall be advisory only.

LEGAL BASIS FOR ADOPTION

The Association of State Wetland Managers in conjunction with Edward A. Thomas, Esq., reviewed federal and state case law together with the Association of State Floodplain Managers' No Adverse Impact policy, and reports that, "Courts are likely to provide strong support for a no adverse impact regulatory performance standard approach" (Kusler, 2003) Some of the points Kusler makes include:

- Courts have broadly and universally supported floodplain regulations against "takings" challenges. Courts have broadly held that regulations may substantially reduce property values without "taking" private property.
- From a common law perspective, a no adverse impact approach for floodplain management coincides, overall, with traditional, common law public and private landowner rights and duties with regard to the use of lands and waters.
- Takings cases that have made headlines, such as Lucas v. South Carolina Coastal Council, 505 U.S. 1003 (1992), Nollan v. California Coastal Commission, 483 U.S. 825 (1987), and Dolan v. City of Tigard, 512 U.S. 374 (1994), were "not clearly based on principles of hazard prevention" and either denied all economic use of lands (Lucas) or permitted the public to enter private property (Nollan and Dolan).
- The most common challenges to regulations in the last 15 years have been claims that regulators allowed development that later caused harm such as flooding or erosion. "[A] municipality is vastly more likely to be sued for issuing a permit for development that causes harm than for denying a permit based on hazard prevention or 'no adverse impact' regulations."
- Courts have held that regulatory agencies do not need to eliminate all uncertainty, including maps with some inaccuracies, if a process exists for refining the data on a case by case basis.[1]

LOCAL CONSIDERATIONS

As with most forms of land and resource regulation, it is often a difficult task to determine the appropriate and necessary balance between the protection of public safety and the rights of land owners to develop their property. Undoubtedly, what occurs on one property can have a significant and lasting impact on other properties and the community as a whole. In the larger context, there is sound rationale and compelling evidence for implementing fluvial erosion hazard regulations in communities that are severely and

[1] Innovative Land Use Planning Techniques: A Handbook for Sustainable Development, Section 2.7 Flood Hazard Area Zoning available on the NH DES website at http://des.nh.gov/organization/divisions/water/wmb/repp/documents/ilupth_flood_hazard_area_zoning.doc

frequently affected by this type of hazard. The benefits of identifying and limiting investment and presence in FEH zones include:

- Target resources to ***minimize future flood impacts, protecting lives, property, and infrastructure, thus enhancing public safety***.
- Reduce economic losses.
- Lessen flood impacts
- Protect infrastructure investments.
- Enhance and update National Flood Insurance Program maps by delineating FEH areas and infrastructure risks.
- Identify transportation infrastructure (roads, bridges, culverts) most threatened by fluvial erosion.
- Aid municipalities in developing and implementing pre-disaster mitigation plans.
- Support identification of areas for future river restoration projects, and the attendant long-term goals of protecting healthy aquatic and wetland ecosystems, and high water quality.
- Improve conditions for recreation and enhance aesthetic values.

EXAMPLES AND OUTCOMES

NEW HAMPSHIRE EXAMPLES

Following are descriptions of two very different case studies of fluvial erosion events and associated erosion hazards in New Hampshire.

Cold River in Alstead, New Hampshire

In October 2005, nine to 11 inches of rain fell over a period of days in parts of New Hampshire - equivalent to a 500-year flood event or 7 inches of rain within a 24-hour period - causing widespread evacuations, loss of life and damage to private property and public infrastructure along the Cold River in Alstead. The primary cause of this catastrophic damage was failure of a culvert and road embankment on Route 123 over the Cold River caused by upstream impoundment of a significant volume of floodwaters during this storm.

The torrent of water that flowed through this breach sent numerous homes and parts of structures, vehicles, debris and contaminants into the river. In the weeks following the event, 36,500 tons of debris was removed from the river channel and floodplain below the breach. Following the 2005 event, the Natural Resource Conservation Service (NRCS), in coordination with other federal, state agencies and local groups, implemented emergency recovery efforts that encompassed twelve towns in three counties in the region. Affected areas were evaluated and qualified under the NRCS Emergency Watershed Protection (EWP) Program to receive disaster relief.

EWP is a federal disaster program established by Congress to relieve imminent threats to life and property caused by declared natural disasters. EWP is authorized stabilize areas and protect public safety, but does not implement replacement or repair of damaged or destroyed property.

As a result of flooding and fluvial erosion during this event, the channels of the Cold River and nearby Warren Brook were drastically altered – widened and deepened in hours by processes that would normally have taken hundreds of years to occur. In addition, the river's aquatic habitat was virtually eliminated and water quality was equally reduced due to severe erosion of the river's banks and the discharge of contaminants into the drainage system.

Suncook River in Epsom, New Hampshire

During the 100-year flood event of May 15-16, 2006, the Suncook River in Epsom dramatically changed course by abandoning its two active river channels around Bear Island and creating a new straighter channel of approximately 5,400 linear feet. This process of a rapid shift in the course of a river is a geomorphic process called avulsion. The new shorter river channel was established in a section of unconsolidated glacial sand deposits through Cutter's Pit, a gravel mining site. The avulsion resulted in rapid removal of large volumes of surface materials from the flat excavated pit area and formation of the new channel. The abandoned channels were left drained, leaving behind isolated pools of surface water void of habitat and aquatic life.

VERMONT EXAMPLES

Following is a summary of the state of Vermont's progress in developing and adopting fluvial erosion hazard ordinances.

Vermont River Management Program

In Vermont, erosion is responsible for approximately 90 percent of flood damage and is as much of a problem as flood inundation. The Vermont River Management Program (RMP) developed a rigorous geomorphic assessment protocol to evaluate fluvial erosion hazards across the state and a public outreach program that incorporated assistance from the regional planning commissions and municipalities. The RMP strongly encourages towns to adopt additional regulatory measures that go above and beyond the National Flood Insurance Program minimum requirements. The RMP provides specific guidance for enhancing flood hazard ordinances and integrating special flood hazard area and FEH regulations with standards National Flood Insurance Program ordinances. The RMP believes the best way to increase public safety, decrease flood damage, and decrease the town's administrative burden is to adopt regulations that exclude most new development from the special flood hazard areas and FEHs. The RMP Fluvial Erosion Hazard program developed maps for communities that show their risk of fluvial erosion hazards and help raise awareness of affected property owners.

Town of Bennington, Vermont

From the late 1800s to the present, the town of Bennington, Vt., has experienced periodic flooding and erosional events that affected a significant portion of the town, including the downtown area. As a result of these major events, the town had undertaken substantial improvements to repair damage and provide flood and erosion protection. These improvements include an investment of $2 million to construct flood protection berms and implement channel stabilization along Roaring Branch, the relocation of U.S. Route 7, and the construction of a diversion structure. At the same time, the town has seen significant development near many of the rivers and waterways that experienced severe flooding and erosion in the past.

In response to a long history of severe erosion and flood events and financial investment, the select board of Bennington adopted a "Fluvial Erosion Hazard Area Overlay District" on April 27, 2009. The purpose of the FEH overlay district is to prevent increases in fluvial (river) erosion resulting from development in identified fluvial erosion hazard areas; minimize property loss and damage due to fluvial erosion; and prohibit land uses and development in fluvial erosion hazards areas that pose a danger to health and safety. The ordinance requires the following standards:

- With a zoning permit, permitted uses are limited to removal of structures and improvements to existing single-family or two-family structures and accessory structures up to 500 square feet.
- With review by the RMP, improvements to existing structures, new residential accessory structures, driveways, access roads, buried utilities, and excavation, filling and grading of land may be permitted.
- Exemption of silvicultural and agricultural activities.
- Prohibited uses defined as involving storage or facilities for floatable materials, chemicals, explosives, and flammable liquids or hazardous or toxic materials.

Bennington is one of three Vermont communities that are currently participating in the FEMA Community Rating System.

Model Language and Guidance for Implementation

The following model ordinance is based on the goals of protecting public safety, promoting hazard avoidance, reducing recovery costs, and protecting water resources. Primary differences between this model and typical flood hazard area zoning include:

- Level of hazard or risk is assumed to be equal across the mapped fluvial erosion hazard area.
- Prohibitions exceed the NFIP minimum standards by prohibiting most new development in fluvial erosion hazard areas.
- Fill and other encroachments that limit process in the active river channel areas or reduce floodplain storage capacity are not permitted.

MODEL ORDINANCE FOR FLUVIAL EROSION HAZARD OVERLAY DISTRICT

I. TITLE AND AUTHORITY

A. The title of this District shall be the ***Town/City of Municipality*** Fluvial Erosion Hazard Overlay District.

B. This ordinance is adopted under the authority granted pursuant to RSA 674:56-II Flood Hazards, and RSA 674:21 Innovative Land Use Controls.

It is strongly recommended that this ordinance be adopted as an overlay district in which the underlying district determines such requirements as lot sizes, density, frontage, setbacks and other dimensional requirements. This ordinance, in most instances, will be more restrictive with respect to uses and development activities within fluvial erosion hazard areas, whereas in such cases the stricter standard would apply.

II. PURPOSE

In the interest of protecting public and private property, and public safety and welfare, this ordinance will serve to limit development in fluvial erosion hazard (FEH) areas, and minimize and prevent future erosion and damage from fluvial erosion. This ordinance will implement development requirements and standards – informed by geomorphic channel assessment and management practices - that recognize a stream's natural evolution and range of stable conditions. Ultimately, the most effective way to prevent hazards associated with fluvial erosion is ***avoidance: limiting future human presence and investments in river corridors***. The objective is to guide and encourage measures and improvements that provide increased property and infrastructure protection, and maintain or restore the hydrologic and geomorphic functions and economic values of the river system.

The purposes of the Fluvial Erosion Hazard Overlay District are to:

1. Protect public and private property, and public safety and welfare.
2. Address fluvial erosion hazards in the existing built environment.
3. Minimize or prevent fluvial erosion hazards in the future.

4. Protect mapped river and stream corridors that are highly subject to erosion due to naturally occurring stream channel migration and adjustment.
5. Limit new development within fluvial erosion hazard zones to minimize property loss and damage due to fluvial erosion.
6. Allow rivers and streams to maintain or re-establish their natural equilibrium to avoid the need for costly and environmentally degrading stream channelization and bank stabilization measures.
7. Implement related goals and objectives of the adopted master plan, and supporting river corridor management plans.
8. Encourage activities that increase awareness of stream processes and the development of river mitigation practices.

III. APPLICABILITY

The Fluvial Erosion Hazard (FEH) Overlay District (hereinafter "FEH Overlay District") shall be superimposed over other zoning districts. All lands to which the FEH Overlay District applies must meet the requirements of the underlying zoning district, other applicable zoning ordinances, and the FEH Overlay District. Where there is a conflict between the requirements of the FEH Overlay District, underlying zoning district or other applicable zoning ordinances or land use regulations, the more restrictive requirement shall apply.

This ordinance should be administered by whichever official in the community administers the local permit requirements and has the function of reviewing proposed development for compliance with local ordinances and regulations, whether it is a building inspector, code enforcement officer, zoning administrator, municipal planner, board of selectmen, or other official. The title of that administrative official or body should be substituted wherever such authority appears in this model ordinance as **[Authority]**.

Optional: A section may be inserted here titled "IV. Findings" that cites the conclusions of the geomorphic assessment upon which the fluvial erosion hazard areas were identified, analyzed, and mapped, and the general purpose for which these areas are being regulated. In addition, reference to recommendations in the local Master Plan supporting regulation and protection of riverine processes and systems, hazard prevention and protection of public safety and property would be appropriate to include in this section.

IV. FLUVIAL EROSION HAZARD OVERLAY DISTRICT AND BOUNDARIES

A. The FEH Overlay District shall apply to all lands in the ***Town/City*** of ***Municipality*** that are identified as fluvial erosion hazard areas in the study ***[river/watershed name] Geomorphic Assessment and Watershed-Based Plan (date)*** conducted by ***[authors/consultants]*** based on the protocols for field investigation of fluvial erosion hazards endorsed by the New Hampshire Department of Environmental Services. Lands located within fluvial erosion hazard areas are identified on the Fluvial Erosion Hazard Overlay District maps, on file at the ***Municipality Town/City*** Offices. These maps and the ***[river/watershed name]*** *Geomorphic Assessment and Watershed-Based Plan (date)* protocols are hereby incorporated as part of this ordinance, and as may be updated and amended consistent with DES's protocols for fluvial erosion hazard analysis, study and mapping. FEH areas can be measured from the Fluvial Erosion Hazard Overlay District

maps, or field verified by a fluvial geomorphologist using GIS and field data collected and analyzed as part of the study ***[river/watershed name] Geomorphic Assessment and Watershed-Based Plan (date)***.

A **fluvial geomorphologist** is a "qualified professional" with expertise in fluvial geomorphology, geomorphic based channel assessment and fluvial erosion hazard mapping. Because fluvial geomorphology is a highly specialized field, the municipality or planning board may employ the assistance of such a qualified professional to review development proposals for which a building permit is requested and conditional use permit applications for conformance with the requirements of this ordinance.

B. If the delineation of an FEH district boundary on a specific parcel of land is brought into question by any landowner located within the district seeking either to exercise a permitted use or apply for a Conditional Use Permit, the ***[Authority]*** shall determine whether the regulations contained herein shall apply. In making such a determination, the ***[Authority]***, Planning Board or its designee shall rely on the technical assistance of the New Hampshire Geological Survey who may act in an advisory capacity to field verify the accuracy of the FEH district boundary (as per RSA 674:56 II. (b)). If a landowner or applicant wishes to enlist the technical assistance of a qualified professional to conduct a similar investigation, the expense for such services shall be the responsibility of the landowner or applicant.

For all development proposed on lands within the overlay district, it is the responsibility of the landowner to prove a proposed project or activity is NOT within a mapped fluvial erosion hazard area. To learn more about delineation of FEH zones, refer to the document "River Corridor Protection Guide: Fluvial Geomorphic-Based Methodology to Reduce Flood Hazards and Protect Water Quality" produced by the Vermont Agency of Natural Resources, available at http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_RiverCorridorProtectionGuide.pdf.

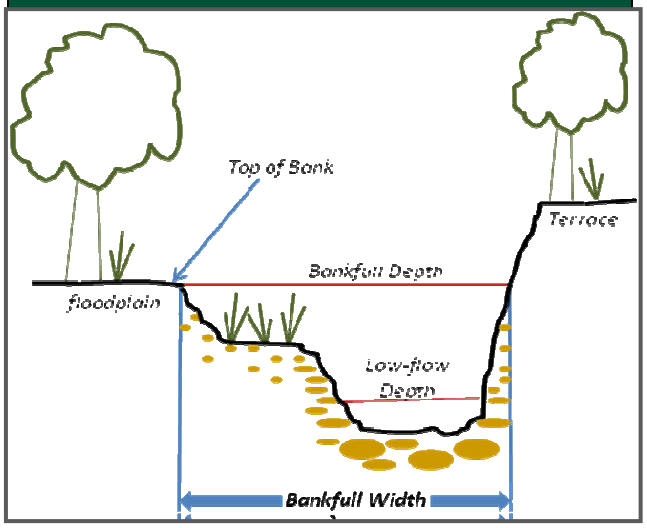
V. DEFINITIONS

For the purposes of the FEE Overlay District, the following definitions shall apply.

Accessory Structure: A structure that is: 1) located on the same parcel as a principal structure or use; 2) detached from and clearly incidental and subordinate to the principal use of or principal structure on a parcel; and 3) clearly and customarily related to the principal structure or use. For residential uses, accessory structures which are incidental to the residential use and not operated for gain, include but may not be limited to garages, garden and tool sheds, playhouses, and swimming pools.

Avulsion: The geomorphic process in which an active river channel shifts location or creates a new active channel. This process can occur very rapidly during a catastrophic flow event (see Suncook River example following) or over a long period of time.

Figure 1. Illustration of bankfull width and top of bank



Bankfull Width: The width of a stream channel when flowing at a bankfull discharge – the water stage that first overtops the natural banks. This flow in New Hampshire, on average, represents the 1.5-year storm event.

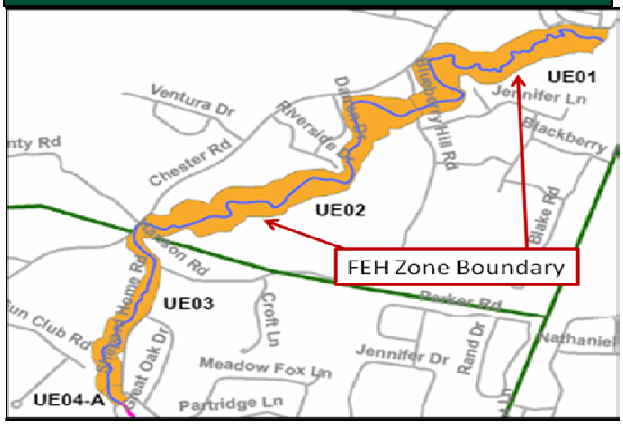
Channel: The area that contains continuously or periodic flowing water that is confined by banks and contained within a defined streambed.

Development: See Land Development.

Fill: Any placed material that changes the natural grade or contour or increases elevation of the land surface, or diminishes the flood storage capacity of land within the FEH area or floodplain.

Fluvial Erosion: The wearing away of river beds and banks by the action of water, which can be accelerated to rates harmful to life, property, and infrastructure during high flow conditions.

Figure 2. Example of a mapped FEH area boundary



Fluvial Erosion Hazard (FEH) Zone (Area): The land area adjacent to stream channels subject to fluvial erosion processes or other channel adjustments as delineated on the current Fluvial Erosion Hazard (FEH) Area Map(s) for the municipality.

Land Development: The construction, reconstruction, conversion, structural alteration, relocation, or enlargement of any building or other structure; any mining, excavation, land fill, or alteration of land surface; any changes in the use of any building or other structure; and change in use of land or extension of use of land.

Low Impact Development (LID): A core set of site design principles based on the concept that opportunities exist within the developed landscape to control the volume and treat the quality of stormwater runoff close to the source in ways that retain natural hydrologic functions. The goals of LID are to: minimize disturbance, preserve and recreate natural landscape features; reduce effective impervious cover; preserve and/or increase hydrologic connections; maintain natural drainage flow paths; and create decentralized detention and infiltration opportunities.

Riparian Area: The upland area adjacent to streams, rivers, lakes and ponds that serves as wildlife habitat and, when undeveloped, is often in a naturally vegetated condition.

Redevelopment: Expansion of or improvement to an existing structure (including change of use), alteration of an existing structure that results in land disturbance, and any other land disturbance that results in grading, filling or removal of vegetation.

Structure: Buildings (including enclosed or covered structures), impervious surfaces, retaining walls over four feet in height, and any permanent construction or installation within or on the ground, including but not limited to septic systems, swimming pools and stormwater management infrastructure and facilities.

The purpose of including in the definition of structure all buildings, physical structures and impervious surfaces is to prohibit encroachments within fluvial erosion hazard areas that permanently limit or prevent natural river processes from occurring. Two primary goals of this ordinance are to: 1) protect public health and safety by limiting damage or loss resulting from the downstream transport of structures and materials; and 2) allow for natural hydrologic and other channel forming processes to occur unimpeded by human presence.

Top of Bank: The vertical point along a stream bank where an abrupt change in slope is evident. For streams in wider valleys it is the point where the stream is generally able to overflow its banks and enter the floodplain. For steep and narrow river and stream valleys, top of bank can be, but is not always, the same as the top of slope (or break in topographic profile). *See previous illustration for Bankfull Width.*

VI. PERMITTED USES

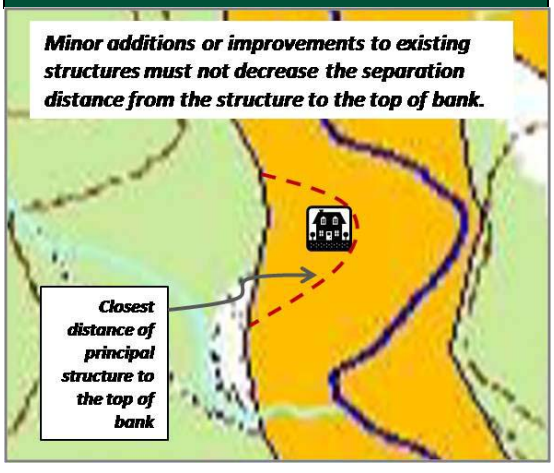
1. The removal of a structure in whole or in part.

2. An existing use or structure in an FEH are, as of the effective date of this ordinance may continue, even if it does not conform to the requirements of this ordinance. Such a nonconforming use or structure may not be extended or enlarged within the FEH area except as permitted under sections VI and VIII.

3. Minor additions or improvements to an existing residential, multi-family, and non-residential structure that:

   a. Cumulatively do not increase the structural footprint in the FEH area by more than 500 square feet or 25 percent, whichever is less.
   b. Does not decrease the structure's distance from the top of bank (i.e. expands the structure closer to the river), as measured horizontally from the closest point of the structure (see Figure 3 for example).

Figure 3. Illustration of closest distance of principal structure to the top of bank



4. The establishment of trails for pedestrian and bicycle activity no wider than four feet for which no grading or filling and minimal removal of vegetation is necessary.

5. New accessory structures that:
   a. Are intended for non-residential uses.
   b. In total on a lot or parcel, have a combined footprint of no more than 300 square feet.

c. On developed parcels or lots, do not decrease the setback distance from the top of bank established by existing structures on the lot.
d. When locating the structure outside the FEH zone is not possible:
    i. Site to minimize the distance from the FEH boundary (located on the same side of the river as the structure); or
    ii. Does not increase the distance from the FEH boundary (i.e. expands the structure closer to the top of bank), as established by and measured horizontally from the furthest point of an existing structure within the FEH zone.

Note: The (combined) footprint of accessory structures should be kept to a minimum - to allow for storage sheds, small garages, and other accessory uses – with the goal of minimizing investment and disturbance in the FEH zone. Existing structures and residences are permitted a slightly larger expansion of footprint as they are primary uses of property. If a property owner proposes expansion beyond the maximum limits for permitted uses, a conditional use permit is necessary.

6. Minor fill or alterations for landscaping and gardening purposes that do not alter the grade or drainage patterns of the land and consistent with local floodplain regulations.

It is recommended that the volume of fill permitted not exceed that which is permitted by the floodplain ordinance or regulations and consistent with NFIP standards. A number of minor areas of fill over time can result in a loss of flood storage by cumulatively increasing flood levels and damage significantly. A requirement for compensatory storage is an essential component of a floodplain management ordinance if fill is allowed as a means of elevating structures or utilities or for landscaping, gardening or other development purposes. Otherwise the ability of the floodplain to store floodwaters is decreased over time, and flood levels and damage will increase.

VII. EXEMPT USES

1. State owned roads and infrastructure, including but not limited to improvements, replacements and new construction.
2. Silvicultural and forestry activities not involving the use of structures and conducted in accordance with New Hampshire Department of Resources and Economic Development Best Management Practices for Erosion Control for Harvest Operations.
3. Agricultural activities conducted in accordance with New Hampshire Department of Agriculture, Markets and Food Best Management Practices for Agriculture.

Floodplain vegetation plays an important role in managing floodwaters and preventing erosion and sedimentation. While most communities will want to allow agriculture and forest management without a discretionary permit, inspection and enforcement of vegetated buffer requirements are essential to protecting those areas subject to fluvial erosion hazards and the maintenance of a well functioning floodplain.

VIII. CONDITIONAL USES

The following uses may be permitted by issuance of a Conditional Use Permit from the Planning Board.

The purpose of this ordinance is to minimize future erosion impacts caused by erosion, protecting **lives, property**, and **infrastructure**, thus enhancing **public safety**. In order to achieve this outcome, it is necessary to manage lands where river processes are active or may occur in the future thus preserving natural channel formation and hydrologic functions. The primary factors when considering inclusion of permitted and conditional uses as part of this ordinance are: 1) minimizing human presence in fluvial erosion hazard areas, 2) prohibiting any uses, activities or structures that if damaged during a fluvial erosion event could result in significant economic loss or damage to other properties or persons; and 3) prohibiting any uses, activities or structures that interfere with natural channel formation processes and hydrologic functions.

1. Improvements to an existing use or structure and redevelopment, that is not permitted in Section VI, and which meets the following:
   a. Conforms to the NFIP regulations.
   b. Does not decrease the structure's distance from the top of bank (i.e., expands the structure closer to the river), as measured horizontally from the closest point of the structure.
   c. When cannot be located outside the FEH zone:
      i. Sited to minimize the distance from the FEH boundary (located on the same side of the river as the structure); or
      ii. Does not increase the distance from the FEH boundary, as established by and measured horizontally from the furthest point of an existing structure within the FEH zone.
2. Modification of an existing nonconforming use to create another nonconforming use provided the Planning Board determines that the proposed use will not increase the nonconformance with the requirements of this ordinance.
3. Grading, excavation and removal of vegetation. Grading and excavation conducted in such a manner as to potentially increase the possibility of channel avulsion within the FEH area or result in instability of the river system is not permitted.
4. Fill, only to elevate existing structures above base flood elevations as required within Special Flood Hazard Areas.
5. Infrastructure and utility improvements necessary to serve existing structures and uses.
6. New or replacement storage tanks for existing structures and uses.
7. New driveways and access roads.
8. Improvements to existing driveways, roads, access roads, bridges and culverts.
9. Stream crossings, channel management activities, and improvements to existing flood control structures.
10. Improvements to existing stormwater management facilities.
11. Public facilities which are functionally dependent upon their proximity to water.
12. Outdoor recreation facilities, excluding structures.
13. At-grade parking for existing structures and uses.

IX. PROHIBITED USES

The following activities and uses are prohibited in the FEH District:

1. New or expansion of existing storage areas or facilities for floatable materials, chemicals, explosives, flammable liquids, regulated substances, or other hazardous or toxic materials.
2. All uses, activities and land development not specifically allowed by subsections VI and VIII.

X. APPLICATION REQUIREMENTS FOR CONDITIONAL USE PERMITS

The following requirements apply to all conditional use permit applications within the FEH district.

1. Application Submission Requirements
   Application for land development listed in subsection VIII shall be reviewed by the Planning Board as a conditional use permit under subsections X and XI prior to the issuance of a building permit. In addition to the application requirements set forth in subsection X.2.a-e below, applications for a Conditional Use Permit approval shall include:
   a. A statement of purpose and need of the proposed development.
   b. A description of alternatives considered to the proposed development, including alternate locations on site, especially outside of the FEH District.
   c. General location map including the relative locations of any existing development, the proposed development and its measurement from the FEH District boundary, the reference line of streams or rivers on the property, and the nearest public road.
   d. Identification of the furthest horizontal distance from the proposed development to the FEH District boundary, and the nearest horizontal distance from the proposed development to the top of bank.
   e. A stormwater management plan, including calculations for the two-, 10-, 50- and 100-year 24-hour storm events. The plan shall incorporate Low Impact Development techniques including but not limited to infiltration, water quality treatment and nonstructural practices, and meet the design guidelines for water quality treatment performance criteria identified in the *2008 New Hampshire Stormwater Manual Volumes 1,2 and 3* (NH DES, as amended).

Note: In order to correctly design Low Impact Development practices, it is necessary to model the two-, 10-, 50- and 100-year 24-hour storm events to ensure coordinated design of multiple best management practices.

The preservation of the predevelopment hydrology is evaluated by comparison of pre- and post-development conditions. This comparison considers four fundamental measures: runoff volume control, peak runoff rate control, flow frequency/duration control, and water quality control.

The one- and two-year storm events are usually selected to protect receiving channels from sedimentation and erosion. These small storms, because of their frequency and cumulative impacts, make the largest contribution to total annual runoff volume (half of the total rainfall volume) and have the greatest impact on water quality and receiving water hydrology.

The two- and 10-year storm events are commonly used for subdivision design, and industrial or commercial development design. To measure peak runoff rate control, the 10- and 50-year storm events are selected to provide adequate flow conveyance design and minor flooding considerations. The 100-year event is used to define the limits of floodplains and for consideration of the impacts of major floods.

f. An erosion and sedimentation control plan that addresses all phases of construction and post-construction conditions (consistent with methods and standards in the *2008 New Hampshire Stormwater Manual Volume 3*, DES, as amended).
g. Applications for a Conditional Use Permit approval shall include a narrative that addresses the development standards in subsection X.2.d.i-v below.
h. Such other information as deemed necessary by the Planning Board for evaluating the application, including the suitability of the site for the proposed development, and compliance with the Review Standards in subsection X.2.d.i-v below.

Depending upon the complexity of a proposal and the conditions on a site, the planning board might request the applicant provide the following information: an existing conditions plan showing topography, vegetation cover, and location of existing development; the area of temporary and permanent disturbance for proposed development activities (may be provided as part of the erosion and sedimentation control plan); calculations of existing and proposed impervious surface coverage; and a landscaping or revegetation plan.

2. Application Review Procedures.
   a. In reviewing an application for a Conditional Use Permit, the Planning Board will forward application materials to the Conservation Commission for review and comment.
   b. The Planning Board may request a review of the application for a Conditional Use Permit by a qualified professional at the expense of the applicant, as established by RSA 767:4, I(g) a.
   c. The Planning Board will schedule a public hearing, although such hearing shall be scheduled for a date not less than thirty (30) days from the submission of the application materials to the Conservation Commission. Failure of the qualified professional designated by the Planning Board to provide comments within thirty (30) days of submission of the application materials to the Planning Board shall not be cause for the Planning Board to delay the hearing.
   d. *Review Standards*. The Planning Board will consider the Conditional Use Permit application, and any recommendations provided by a qualified professional and comments from the Conservation Commission. The Planning Board may approve a Conditional Use Permit application upon finding that the proposed development within the FEH District meets all of the following standards:
      i. No reasonable alternative location for the proposed development outside of the FEH District is available.
      ii. The proposed development will not increase the susceptibility of the property to fluvial erosion damage.
      iii. The proposed development will not increase the potential for damage to other private or public properties or public infrastructure due to fluvial erosion.
      iv. The proposed development will not increase the potential of materials being swept onto other lands or into the stream by fluvial erosion, thereby causing damage to others from fluvial erosion.
      v. The proposed development will not cause an undue burden on public services and facilities including roads, bridges, culverts, and emergency service providers during and after fluvial erosion events.
   e. For uses and activities approved as a conditional use, it is strongly encouraged that an undisturbed buffer of native tree, shrub and undergrowth vegetation (as measured from the stream reference line) be maintained, restored or allowed to naturally regenerate on the property to the maximum extent practicable. The width of the buffer shall be no less 25 feet or greater, as recommended by

the reviewing qualified professional or the Planning Board, if site conditions warrant additional stabilization of land and soil.

XI. OTHER REQUIREMENTS FOR APPROVED CONDITIONAL USES

As part of a Conditional Use Permit approval, the Planning Board may include certain conditions that must be implemented as part of the development approved within the FEH District. The purpose of such conditions would be to correct existing erosive conditions caused by man-made disturbances or activities (i.e., improper stormwater management or land alteration within the FEH zone), and safeguard the property and others from potential fluvial erosion damage in the future.

The goal of such conditions of approval are **NOT** to prevent any stream bank erosion from occurring naturally or to permanently "fix" the position of the river in one place, that would be contrary to the intent of this ordinance. Natural channel adjustments and migration occur through erosive processes. Thus, the purpose of such conditions to permit development in an FEH area is to address man-made encroachments or degradation that negatively impact natural stream processes. Actions that restore fluvial geomorphic processes are desired, while heavily engineered hard structural projects should not be encouraged.

A qualified professional designated by the Planning Board shall review the Conditional Use Permit application and make recommendations to the Planning Board regarding appropriate preventative and corrective measures that will address fluvial erosion hazards on the site. Such conditions would provide specific strategies to prevent erosive conditions from occurring within the FEH District, on the site and adjacent properties and those properties downstream.

Vegetation plays an important role in managing fluvial erosion hazard areas by slowing flood flows, and stabilizing soils and surface materials, thus preventing erosion and sedimentation. While agriculture and forestry activities are permitted by federal and state laws, preservation and reestablishment of vegetated riparian areas are an effective cost-saving method of providing land and soil stability in fluvial erosion hazard areas.

For development approved within the FEH District, such conditions may include, but not limited to, implementation of the following preventative and corrective strategies:

1. Where riparian areas are not fully vegetated, an area of native vegetation shall be planted on the site equivalent to the area of impervious surface permitted or to fully vegetate the riparian area, whichever is less.
2. Allow natural regeneration of non-vegetated riparian and other areas.
3. Protect riparian areas with easements and maintenance agreements.
4. Implement stormwater management for existing development if none is provided or improve existing stormwater management practices.
5. Provide water quality treatment for runoff generated from existing and new impervious surfaces.
6. Remove structures and other impervious surfaces where feasible.
7. Flood proof existing structures and infrastructure.

8. Implement infrastructure improvements to reduce restrictions to river flow (i.e., bridges, culverts and dams).
9. Relocate or improve roads and crossings to restore natural river channel processes.
10. Restore floodplain functions, or stabilize land or soil to repair active erosion (i.e., head cuts, nick points and gullies).
11. Manage land use and activities that cause erosion and sedimentation problems.

Optional Strategies

Other preventative and corrective techniques are possible however they require approval by DES and must be paid for by the applicant/land owner. DES approval of these types of corrective measures or mitigation activities must be coordinated with timeframes for the local Conditional Use Permit approval process, or included as a condition of a Conditional Use Permit. Such corrective measures or mitigation activities might include the following.

Channel and Bank Stabilization and Restoration

In recent decades, more environmentally-friendly river restoration techniques including "natural channel design" have been developed and implemented. While these techniques still try to control fluvial processes, the methodology attempts to employ a more natural channel configuration, and stable channel and bank conditions. These restoration techniques can be an effective tool for mitigating fluvial erosion hazards by slowing bank erosion or limiting lateral channel migration. Techniques include nonstructural enhancements of banks including re-vegetation and stabilization, and reconfiguration of channel features using natural materials.

The high cost of designing and installing restoration projects limit the usefulness of restoration as a general approach to flood hazard mitigation. In addition, restoration projects can be prone to failure, either during high flow events during the construction or pre-construction phases, or if the design does not adequately reflect existing fluvial conditions.

Barrier Removal

This strategy may include replacement of undersized culverts and bridges, and removal of channel constrictions, including low dams, berms and other types of impoundments.

XII. VARIANCES AND APPEALS

1. Any order, requirement, decision or determination of the ***[Authority]*** made under this ordinance may be appealed to the zoning board of adjustment as set forth in RSA 676:5.

2. The granting or denial of a Conditional Use Permit by the Planning Board may be appealed to the Superior Court, as provided for in RSA 677:15. A Planning Board decision on the issuance of a Conditional Use Permit cannot be appealed to the Zoning Board of Adjustment (RSA 676:5 III).

XIII. WARNING AND DISCLAIMER OF LIABILITY

The provisions of this ordinance do not imply that land outside the designated FEH Overlay District is free from fluvial erosion hazards. Further, these provisions shall not create any liability on the part of the municipality, or any employee thereof, for loss or damages that result from reliance on these regulations or any administrative decision lawfully made hereunder.

It is the responsibility of the municipality to evaluate the FEH District and update and/or revise the FEH zones and maps as conditions in the watershed change over time and based on the best data and technical guidance available.

With respect to updating this ordinance, language may be added or revised as appropriate based on the most accurate and comprehensive data and maps available of a community's fluvial erosion hazard areas, as identified by geomorphic assessments conducted in the community and/or watershed.

It is the responsibility of the planning board to engage a professional qualified in the science of fluvial geomorphologic processes to review and evaluate Conditional Use Permit applications to ensure compliance with ordinance requirements and protection of the public health and safety.

REFERENCES

Lane, E.W. 1955. The Importance of Fluvial Morphology in Hydraulic Engineering, American Society of Civil Engineering Proceedings, 81, paper 745:1-17.

Kusler, Jon. A. 2003. Legal Questions: Government Liability and No Adverse Impact Floodplain Management, Association of State Floodplain Managers.